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Monitoring structure and physical features of NiTiO3 thin films grown by RF-magnetron sputtering

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Nickel titanate $NiTiO_3$ (NTO) is a transition metal oxide adopting three possible structures: Ilmenite structure (IL), which is the most stable, $LiNbO_3$-type structure (LN) and corundum-type structure (CR). NTO-IL is an n-type antiferromagnetic semiconductor used as gas sensors and as photocatalyst in the removal of organic pollutants from water. NTO-LN is predicted, by theoretical studies, to display a ferroelectric order in addition to its antiferromagnetic order. NTO-CN is a disordered structure usually stable at high temperatures (>1200°C).
While NTO-IL synthesis and physical properties have been reported in literature by several studies, few papers report on NTO-LN and NTO-CR compounds. Scarcity of reports is mainly due to its complicated synthesis conditions. Indeed, bulk material synthesis requires very high pressure and high temperature, and monocrystalline substrates with specific orientations for thin films growth. NTO-LN/CR synthesis has never been reported by magnetron sputtering despite the ability of this method to stabilize metastable structure by inducing residual and/or epitaxial stresses.
This work is focused on the preparation of NTO thin films by magnetron sputtering. NTO is sputtered from metallic targets (Ni and Ti) in convergent configuration on various substrates. Plasma parameters, substrate's nature and deposition temperature are the main keys to monitor structure and preferred orientation of NTO. Chemical composition and morphological features of NTO thin films are investigated by Energy Dispersive X-ray spectroscopy and Scanning Electron Microscopy, respectively. The crystalline structure is examined by X-Ray diffraction, Raman spectroscopy and Transmission Electron Microscopy. Ferroelectric domain configuration and switching are investigated by Piezoelectric Force Microscopy. Thanks to the parameter optimization of magnetron RF-sputtering technique, control of NTO structure (IL, LN or CR) is achieved. Physical properties were related to the processing conditions of NTO films and their structural, morphological and physical features.

Keywords
NiTiO3, multiferroic, sputtering